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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

NON-FERROUS METALS

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REG. T. M.

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TEXACO PETROLEUM PRODUCTS


MECHANIZATION:
Key to modern mining
Around the turn of the century, mining, as from time immemorial, was done largely with pick and shovel. The motive power was human muscle. But the Age of Progress kept demanding: "More metal!" That meant faster methods of getting it from the ground had to be devised.
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LUBRICATION

A TECHNICAL PUBLICATION DEVOTED TO THE SELECTION AND USE OF LUBRICANTS

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NON-FERROUS METALS

Lubrication of Mining, Concentrating and Smelting Machinery

METALS mining has been an industry since prehistoric times. It was several thousand years ago that some observant prehistoric man discovered pellets of pure iron or copper in the ashes of a fire he had built by chance on the surface cropping of an ore vein of one of these metals. That was the beginning of the association of fire with the conversion of metallic ores to more or less pure metal. From copper and iron it was but a step to silver and gold.

There was no need for lubrication, however, in these early days, that came later, when the machine age had developed suitable machinery and when mass production in mining, — abetted by the railroads, building construction and the automotive industry, — coordinated processing of ores from the mine to the relatively pure metal.

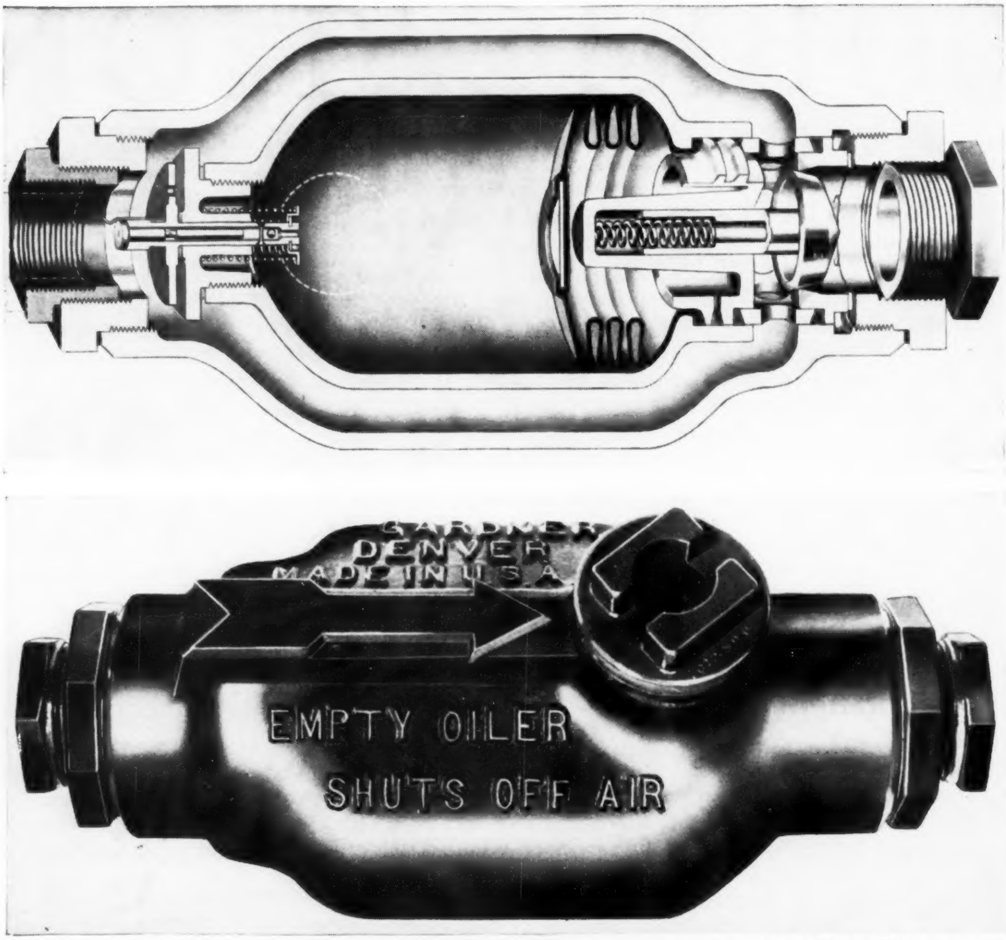
Then the lubricating engineer came into the picture. As the emissary of the Petroleum Industry he has fitted tailor-made lubricants to tailor-made machinery. The ability of the non-ferrous mining people to meet present-day requirements for a metal supply vital to war or peace, testifies to the high degree of cooperation which prevails.

MINING PROCEDURE

Mining operations can be divided roughly into two types, i.e., open pit or surface mining, and underground or shaft mining. The choice depending on the structure, location and richness of the ore. Copper may be found as comparatively pure metal, or in the form of oxides, carbonates, or sulfides. Zinc, in turn, is found chiefly in the form of zinc sulfide or zinc carbonate; lead principally as lead sulfide or galena; aluminum is mined almost universally as an oxide, by reason of its affinity for oxygen. Tin occurs chiefly in the mineral cassiterite; cadmium is found largely as a sulfide; tungsten, molybdenum and vanadium occur chiefly as oxides; nickel is found associated with cobalt or copper ores and sometimes produced as a by-product in the refining process.

Copper ores are surface mined or stripped from open pits by power shovels as in Arizona, Utah or Nevada, for example; or shaft mined as in Montana. Other ores however, are usually found some distance below the surface, so shaft mining generally is practiced. In either method after the ore has been broken out from the vein by drilling and blasting it must be crushed and put through a concentration process before going to the smelter.

Modern mining has become largely electrified, consequently air power and electric power predominate below ground. Above ground electricity is used for some power shovel operation, for car handling and in the smelter for pump and refining machinery operation.



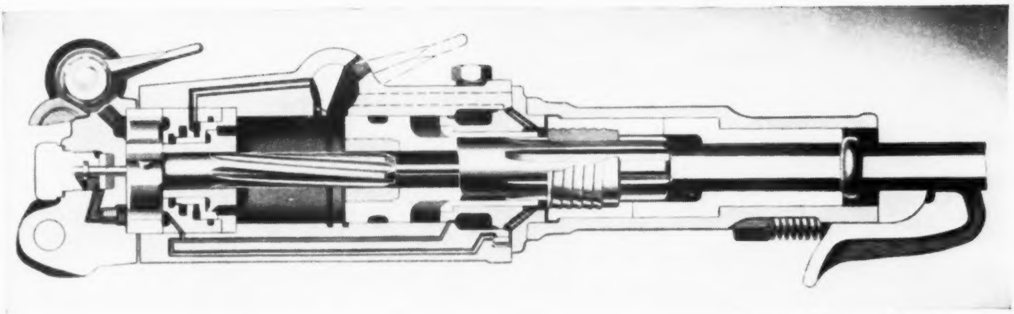
Courtesy of Gardner-Denver Company

Figure 1 — The Gardner-Denver Model L012 automatic line oiler showing interior and exterior construction. This oiler is unique in that air in the line is automatically shut off when all the oil has been used up.

DRILLING THE FIRST OPERATION

Both open pit and underground or shaft mining of non-ferrous metals starts with breaking away the ore within the vein from the surrounding rock. This requires drilling and blasting. The conventional air-powered rock drill is mainly used for this purpose. As the preliminary and one of the principal operating mechanisms, its lubrication plays an important part in keeping ore flowing to the smelter. Drill operation must be understood in selecting a suitable lubricant. The modern rock drill does its work by percussion or rapid hammering, or, in some cases by a combination of pressure and rotation. Where percussion is employed, air pressure acts on the tool mechanism in much the same manner as steam acts on the pistons of a steam engine. This requires a cylinder with suitable piston and valve arrangement for the admission of air at the proper time, according to the number of strokes per minute or percussive frequency required. Two sets of valves are normally involved, i.e., the throttle valve which enables the operator to control the amount of air admitted; and the working valve which, through suitable timing, controls the frequency with which the air pressure is allowed to react on the piston.

Effective use of air has a direct relation to the power bill in respect to wear of equipment and loss of power. In cold weather, the selection of suitable lubricants for drills which may be exposed to the elements is especially important, for low temperature increases the resistance to flow, thereby rendering petroleum lubricants more sluggish and less likely to reach all the mechanisms in certain types of tools. Hence the importance of low pour test and relative viscosity in predicting to what extent dependable lubrication will be maintained.



Courtesy of Ingersoll-Rand Company

Figure 2 — Sectional view of the I-R J-50 Jackhammer.

Lubrication Procedure

While the type and extent of refinement of the lubricants employed have much to do with efficient operation of any rock drill or pneumatic tool, the means whereby the former are admitted or distributed have a marked effect upon their ability to function effectively. Even the best rock drill oils may fail to do their work if they are used in such a manner as to be unable to reach all the wearing elements of the tools. Many authorities feel that probably more failures or complaints arise from ineffectual lubrication through misusage of such oils, or lack of knowledge as to the requirements for good rock drill lubrication, than from any average operating condition. In most cases, this is due to lack of appreciation of the lubricating requirements of the equipment.

Rock drill lubricants are refined to function with a minimum of fluid friction, and a maximum of sealing power in the prevention of air blowby past the pistons. Needless to say they must have excellent lubricating ability, and a pour test commensurate with the operating requirements so as to function in low temperature service. Naturally the operator must use these products intelligently, in accordance with the recommendations of the builders of his tools, and the oil company from whom he purchases. Makeshift ideas cannot be tolerated; today, continued and efficient operation along with the necessity for maximum production demand that the most modern means of lubrication be used.

Air Line Oilers

Air line oilers are generally intended for the handling of fluid oils. They work on the principle of suction, atomization or pulsation. For best operating performance an air line oiler should be located six to eight feet ahead of the drill. In the suction type, as the air passes through the working mechanisms it draws the requisite amount of oil from the reservoir by suction. Where atomization is involved, there is a needle or pin valve through which a certain amount of air passes to carry the required lubricant forward into the tool. In either case, air as it passes through the lubricator becomes charged with oil in finely atomized condition. This insures that there will be complete distribution of oil to all parts of the tool.

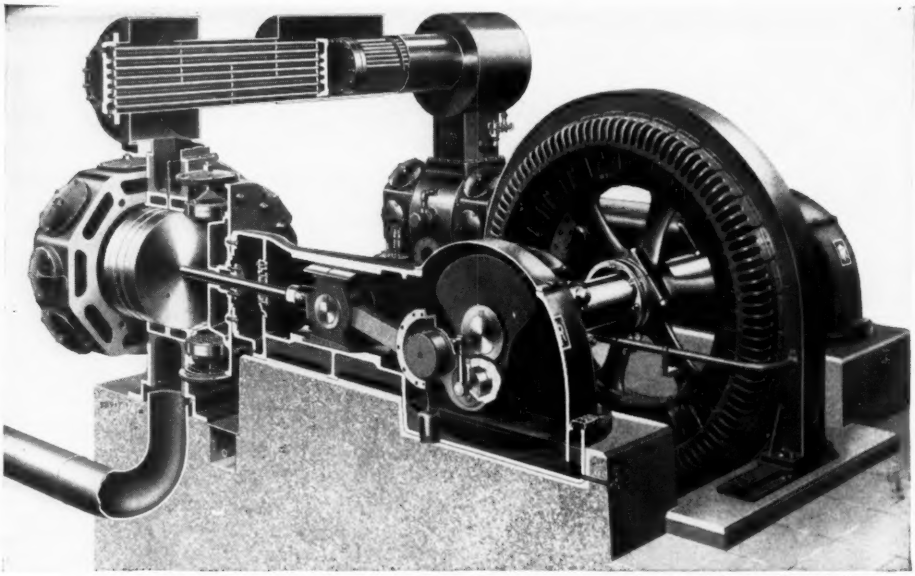
The pulsation type lubricator operates through the action of the reciprocating piston. This keeps a regulated flow of oil going to the air and tool mechanisms. Such a lubricator is frequently built with an oil capacity sufficient to last a working shift in order to reduce the possibility of lack of lubrication. Control of the oil flow is helpful not only to reduce consumption but also to reduce the possibility of dieseling or fog.

Lubricant Characteristics

Rock drill lubricants are specialty products, prepared to meet certain specific conditions of operation and means of application in drills, stopers and drifters. When valves, pistons and other rotating and reciprocating elements are to be oil lubricated and dry air is used, a straight mineral, low pour point oil is often satisfactory. The viscosity normally should be from around 500 to 750 seconds Saybolt Universal at 100° Fahr. and the oil should be selected to develop the least amount of hard carbon.

In service where wet air is used it will be necessary to compound the base oil with a certain amount of fixed or fatty oil to offset the washing effect of water.

In turn where the service is unduly severe an oil prepared with an E.P. additive may be required. Extreme pressure properties are advantageous in rock drill oils where rifle bars, nuts and other moving parts must be protected against wear in severe service, for example, where deep holes are to be drilled or very hard ores are involved. The addition of a rust inhibitor further improves the protective nature of such a lubricant and insures against rusting of drill parts, especially where machines are stored underground or exposed to unusually damp atmospheric conditions.



Courtesy of Ingersoll-Rand Company

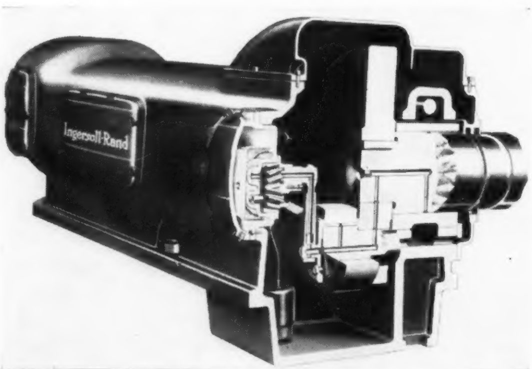


Figure 3 — The I-R synchronous motor-driven PRE compressor showing (above) crank-case and connecting rod details and (at left) features of the positive-pressure lubrication system, including the built-in oil pump.

ORE GATHERING

Ore is gathered according to the type of mining involved. In underground work the modern scraper-loader is widely used. In open pit or surface mining the power shovel or tractor-type loader is applicable. The scraper-loader as specifically designed for underground mining is a gathering, conveying and materials handling machine. The gathering or scraping mechanism digs into the loosened ore and drags it on to the conveyor or chute which then unloads into the mine cars.

Lubrication of any ore handling machinery must be given careful consideration, with due regard for the protection which proper choice of lubricants will insure, because the machine parts may be continually in contact with abrasive materials which promote wear. Gears, chains, wire rope and bearings are involved, according to the design of the machine. In addition, on certain loaders built for hydraulic operation, oil will be required in the hydraulic system. Such oil also may serve to lubricate the interior parts. Automatic lubrication has received very careful study in appreciation of the productive importance of the loading machine.

Automatic lubrication may involve lubrication of gearing and gear shaft bearings by splash from the oil in a reservoir which is formed by the gear case, or the use of some form of pressure lubrication, handling either grease or oil, according to requirements of the wearing elements and the manner of housing.

Automatic lubrication is advantageous in that it usually enables the lubricant to perform its intended function of reducing metallic friction and wear more effectively. Furthermore economy of lubricants results, for as a general rule such lubricating systems are more nearly of oil-tight nature. This prevents entry of dirt or mine water, as well as leakage of lubricant.

The design of the system dictates as to whether oil or grease should be used. Where the operating mechanism can be served from a central reservoir, it will usually be advisable to use a relatively heavy bodied, straight mineral oil or a mild E.P. gear oil. Such products will follow all gear and pinion teeth readily, will maintain a suitable film of lubricant in all normal bearing clearance spaces, and will insure that chain roller or link mechanisms receive an adequate amount of lubricant to protect the interior parts.

It is practicable, for example, also to use a grease of fairly soft consistency in gear cases of tugger hoists. In fact, this is the recommendation of some builders. Care should be taken, however, that any grease used is compounded with a high grade of low pour test mineral oil; otherwise, should low temperature conditions prevail, as for example in open pit mining, there may be possibility of congealment and lack of sufficient lubrication, especially in low bearing clearances.

When the machine is built for hydraulic operation of the gathering, shoveling or conveying elements, a high grade machine or engine oil of around 200 to 300 seconds Saybolt Universal viscosity at 100° Fahr. may be used. Here again good fluidity is a factor in order to assure adequate lubrication of plunger rods, etc. without excessive power consumption at low temperatures. Resistance to rust and oxidation as imparted to the oil by suitable additives increases the durability of the oil and protects the machine parts against rusting when operating in the presence of water or moist air.

The exposed parts of any machine used for ore loading, such as the chains, tractive elements, bearings, etc., which may require periodic hand lubrication can be served by machine oil of about 200 seconds Saybolt Universal viscosity, or a medium consistency grease, according to the means provided for application.

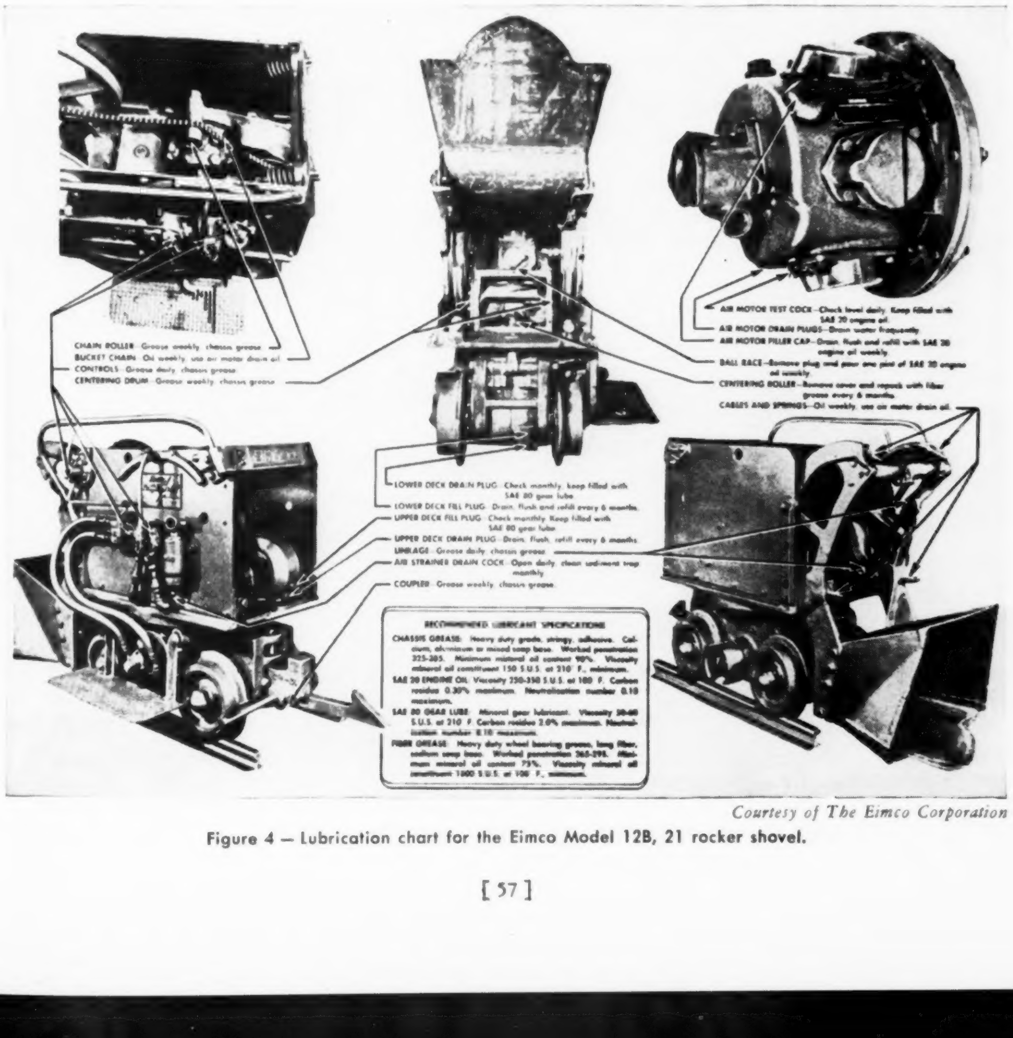
Exposed gears, in turn, require a straight mineral, semi-fluid lubricant. Such a product will insure adequate protection of gear teeth, with minimum loss through dripping or throw-off by centrifugal force during operation.

MINE CARS

Mine car wheel bearings are probably the largest consumers of lubricants, particularly in underground mining. As these bearings carry considerable loads they must be protected against failure. Effective lubrication is a decided factor in keeping them in service.

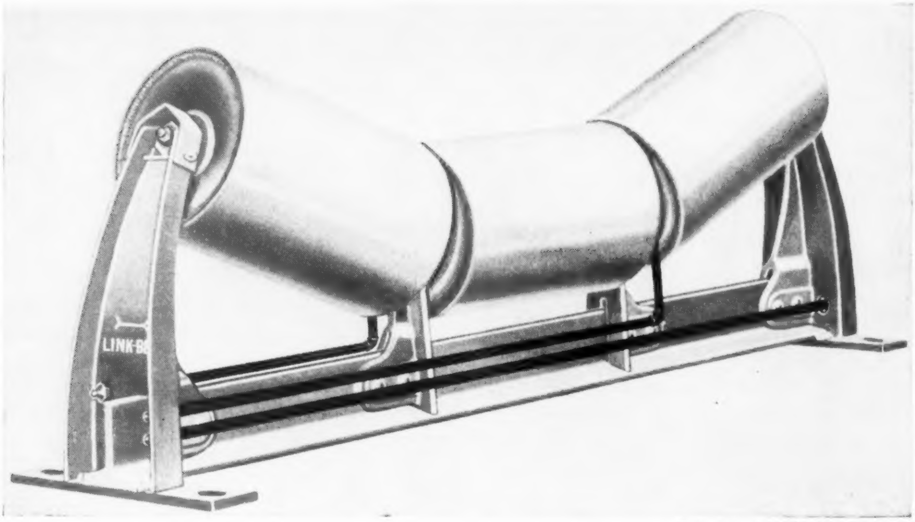
The type of bearing naturally dictates the type of lubrication. Such bearings may be grouped in four basic classifications, according to whether they involve:

sleeve construction
hollow axles
self-oiling or cavity wheels or
ball or roller bearings



Courtesy of The Eimco Corporation

Figure 4 — Lubrication chart for the Eimco Model 12B, 21 rocker shovel.



Courtesy of Link-Belt Company

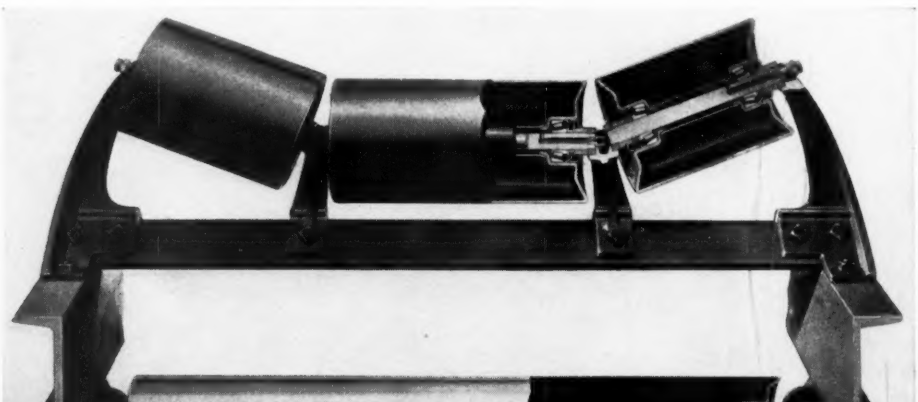
Figure 5 — A Link-Belt conveyor idler showing grease pipe extensions for lubricating the idler rolls from one side of the conveyor.

The Sleeve Type

Sleeve type bearings employed in journal boxes often are so constructed as to enable the use of oil-saturated wool yarn or waste packing. Their lubrication is assured by regular attention to loosening of the waste, or oil-carrying material and resaturating with a suitable grade of straight mineral bearing oil or a light grade of liquid grease. Matting or glazing of the oil-carrying materials is detrimental, for this will reduce the capillarity of the packing, and prevent circulation of the lubricant. Stirring or loosening of the packing periodically will help to retard glazing of the surface in contact with the journal.

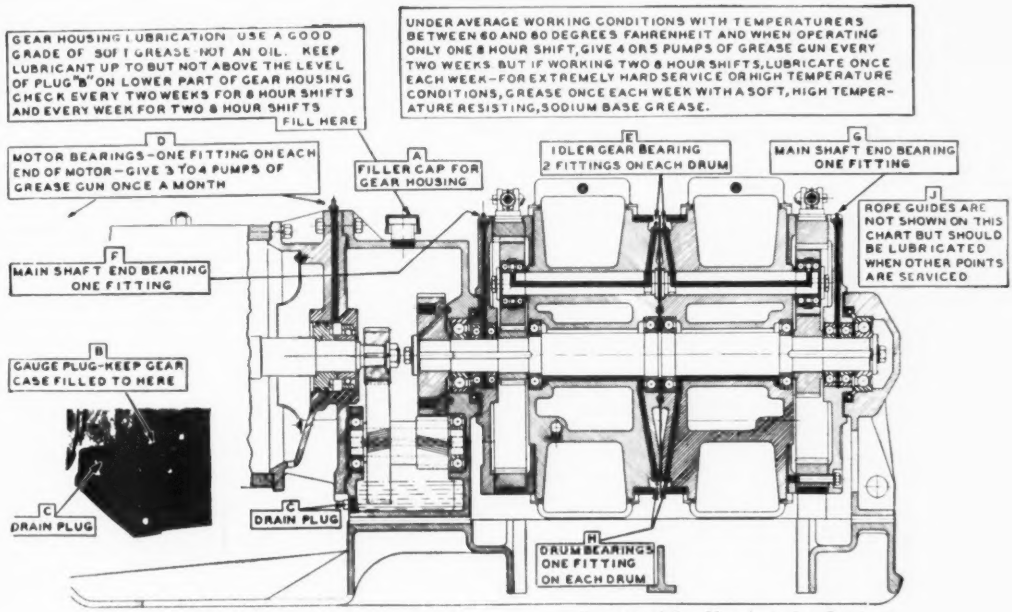
Hollow Axle Design

In this type mine car wheel the axles are of tubular steel. Since these are hollow throughout their entire length they serve as reservoirs for lubricant. At the outer end of the axle, near each extremity is a flat valve seat and a spring loaded valve similar to an ordinary check valve except that the guide is several inches long. A spiral spring encircles the valve stem and compels the valve to maintain a



Courtesy of the Jeffrey Manufacturing Co.

Figure 6 — A Jeffrey Belt idler showing construction as well as lubrication of the carrying and return idlers.



Courtesy of Joy Manufacturing Company

Figure 7 — Lubrication chart for a Sullivan double drum scraper hauler with foot mounted type motor.

bearing on the seat which prevents leakage of lubricant from the axle. At the point on the axle corresponding to the bearing surface of the wheels, the axle tube is perforated sufficiently to permit passage of the lubricant from within the axle outward to the contact surface of the axle with the bushing of the wheel hub. As a result lubricant is constantly working its way outward to maintain a protective film between the wearing parts, and when the proper type of grease is used, the cost of maintenance and parts renewal should be very low.

An N.L.G.I. No. 0 grease or a medium-bodied oil can be used according to the design of the bearing. Normally where axle sealing valves function effectively, a charge of lubricant within the axle may suffice for several weeks.

Self-Oiling or Cavity Wheels

Mine car wheels of this type are lubricated from an oil or grease reservoir around the hub. During rotation, the lubricant is fed to the axle or journal through port holes staggered in the hub. This goes on whether the car is idle or running slowly. At higher speeds centrifugal force tends to carry the lubricant to the outer surface of the reservoir. For this reason, due to possibility of leakage, the amount of lubricant used should be carefully controlled. In general, the lubricant level should be kept on a line with the lower part of the axle, being checked when the car is standing idle.

A highly refined straight mineral engine or car oil of from 300 to 750 seconds Saybolt Universal viscosity at 100° F. will in general be best suited to the operating conditions, and will insure most complete protection of the bearings. Where service in cold weather is essential, the oil, of course, should be able to flow through the distributing ports readily. It is also practicable to use a comparatively light grease of N.L.G.I. No. 0 grade where there is possibility of oil leakage.

Ball and Roller Bearings

Ball or roller bearings are being widely used in modern mine car design; their use facilitates sealing against loss of lubricant or entry of contaminating foreign matter. Low maintenance costs and consumption of lubricant also accrues.

Due to possibility of heavy loading, a grease for such bearings should be compounded with a fairly high viscosity straight mineral oil in order to obtain load carrying ability. The seals also make the use of high quality greases good insurance.

An N.L.G.I. No. 0 or No. 1 consistency grease is well suited for such bearings. Where the rollers are of solid, cylindrical or tapered construction, a somewhat more inert grease may be advisable than is used on hollow flexible bearings. Such a product will furnish a better cushion between the axle and rollers than a more liquid grease. Furthermore, it will also form a better seal against possible entry of dust, dirt or water, provided the bearing itself is equipped with a reasonably tight seal.

Lubrication of flexible roller bearings in turn can be done with a semi-fluid or so-called liquid grease. The usual construction of bearings of this type enables the hollow spaces within the rollers to serve

as grease reservoirs. The lubricant therefore must be sufficiently fluid to pass through and penetrate to all the surfaces of contact. If it remains inert within the rollers, or tends to gum, starved lubrication of the bearing contact surfaces may result.

Mine Locomotive Gears

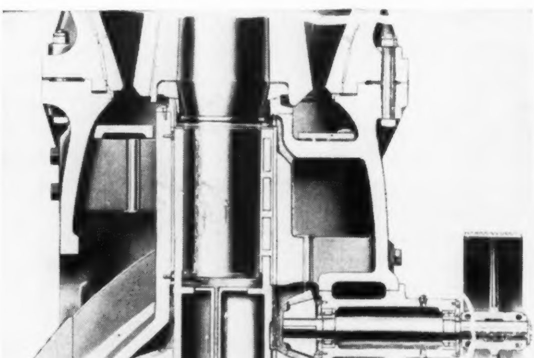
Locomotive gearing and exposed chain drives should be lubricated with a straight mineral, residual lubricant of about 1000 seconds Saybolt Universal viscosity at 210 degrees Fahr. A product of this type will adhere tenaciously to the gear teeth and overcome vibration and wear. Where gears and chains are enclosed in oil-tight housings, however, a somewhat lighter lubricant can be used to advantage. Lower viscosity in normal operation will be conducive to reduction in drag and power consumption. The pour test of any such lubricant must be considered, for the probability of low temperature service above ground always will prevail. The degree to which satisfactory performance can be predicted is indicated by the pour test and relative change in viscosity with change in temperature. Obviously, a gear lubricant should be capable of following the gear teeth readily. If it balls up or drags at low temperatures considerable tooth wear may result.

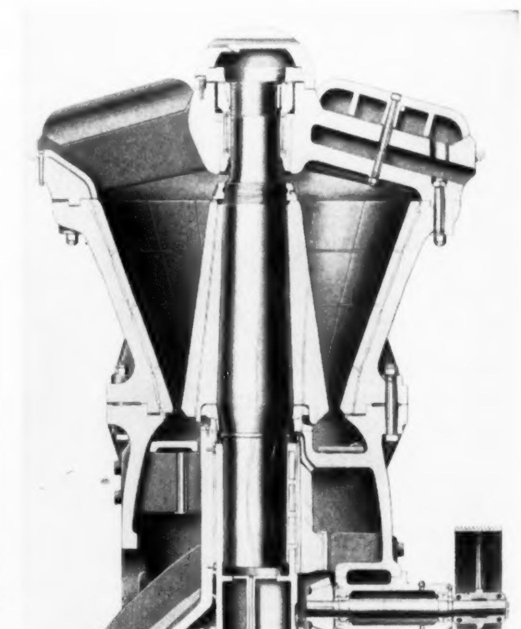
CONCENTRATING – ORE DRESSING

Ore dressing is a process of concentration whereby non-metallic silicious or other materials of no economic value (gangue) are removed from the ore prior to sending the valuable separated concentrate to the smelter. Normally, crushing to reduce the size of the ore is the first step. Recoverable minerals are usually found in chemical compound with oxygen or sulfur and blended with silicates or carbonates in rock formations. In order to separate the minerals from the gangue, the rock or ore must be broken up by crushing and grinding to sufficiently small size so that each particle of mineral is freed from the gangue. The valuable minerals are then separated from the gangue and from each other to a certain extent, by gravity concentration and/or flotation.

In order to secure the necessary fineness of grind, ore is crushed through primary and secondary crushers, and then usually ground by means of ball or rod mills in closed circuit with an adequate hydraulic counter-flow classifier until it finally reaches such a state of fineness that it overflows the classifier in a mixture of ore, gangue, and water. It is then concentrated either by gravity, being fed over oscillating-reciprocating tables, or goes direct to the flotation cells, where selective flotation takes place, and the concentrates are taken off with the froth. Sometimes both gravity type oscillating-reciprocating tables and flotation are employed for complete concentration and recovery of the mineral particles.

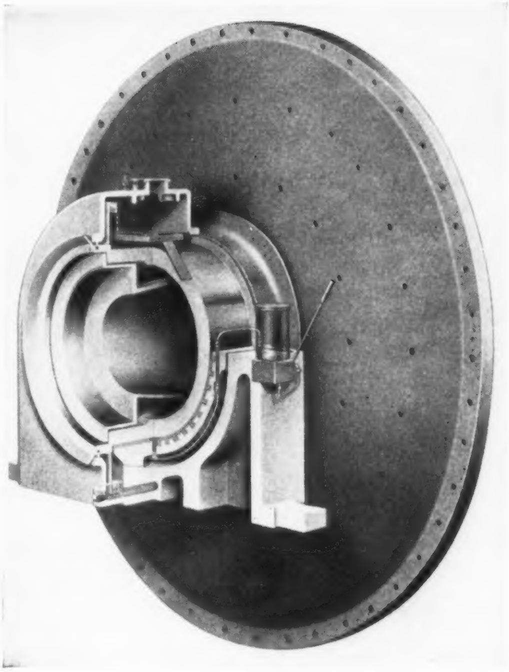
Concentration therefore, yields two products – a valueless rock tailing which is rejected to waste, and valuable concentrates containing the greater part of the metal content in highly concentrated form.





Courtesy of Allis-Chalmers Mfg. Co.

Figure 8 – Sectional views of a Superior McCully crusher. At left note details of the oiling system and oil flow indicated by arrows; at right the crusher complete.



Courtesy of Allis-Chalmers Mfg. Co.

Figure 9 — A typical A-C oil-lubricated trunnion bearing with starting lubricator cooling coils not shown. Trunnion liner shown for spout feeder.

These concentrates are subjected to heat treatment in the smelter to obtain the base metal. As it is not entirely pure this smelter product then is sent to the refinery, where it is reduced to virtually pure metal and prepared for market as castings (pigs or bars), plates or other special form.

Crushing

This involves a reduction in size of the ore. Three stages may be required, according to the size of the lumps and the hardness of the rock, i.e., primary, secondary and grinding. Primary crushing may be done by either a jaw crusher or a gyratory, dependent upon the character of the ore, the head space available or convenience. Secondary crushing also may use the jaw crusher or gyratory, or, perhaps a cone crusher. Rod or ball mills are used for final grinding.

The Jaw Crusher

The jaw crusher involves a pair of steel jaws (lined with special steel for toughness) which converge at an angle with respect to one another. The frame which forms one of these elements is fixed; the other is a swing jaw which rocks backward and forward to reduce the space at the bottom of the crushing chamber and crush the ore as it works its way down between the jaws.

High back pressures are developed during this operation. They are carried by the toggle and pitman bearings which generally are of the water-cooled sleeve type, although oil cooling also is practicable. These bearings require very careful lubrication, so adequate seals generally are provided to prevent contamination and leakage. The pitman bearing carries the pitman which is the heavy steel casting which oscillates with its bearing as the point of suspension. Pressure grease lubrication is widely employed, although reservoirs in the bearing caps equipped with wool waste may also be provided. This waste can be saturated with lubricant or a special wool yarn grease can be used.

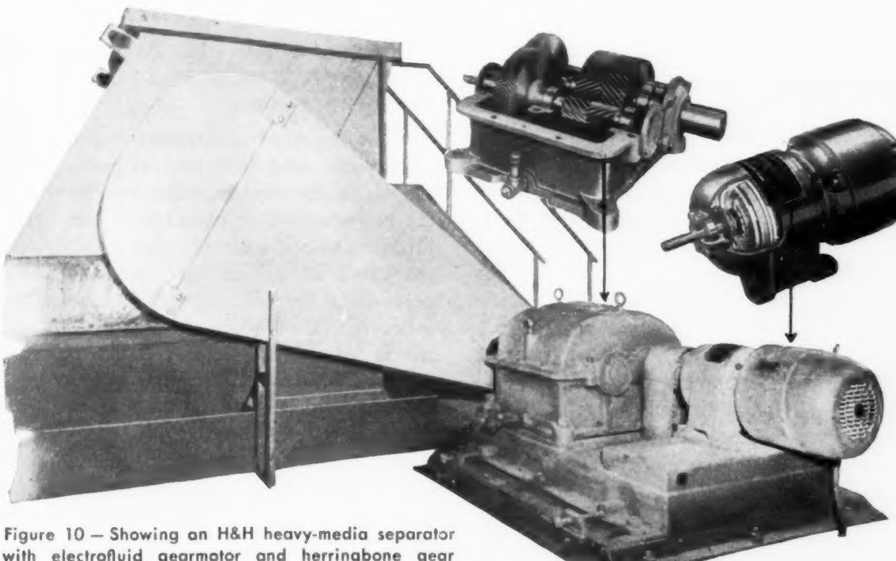
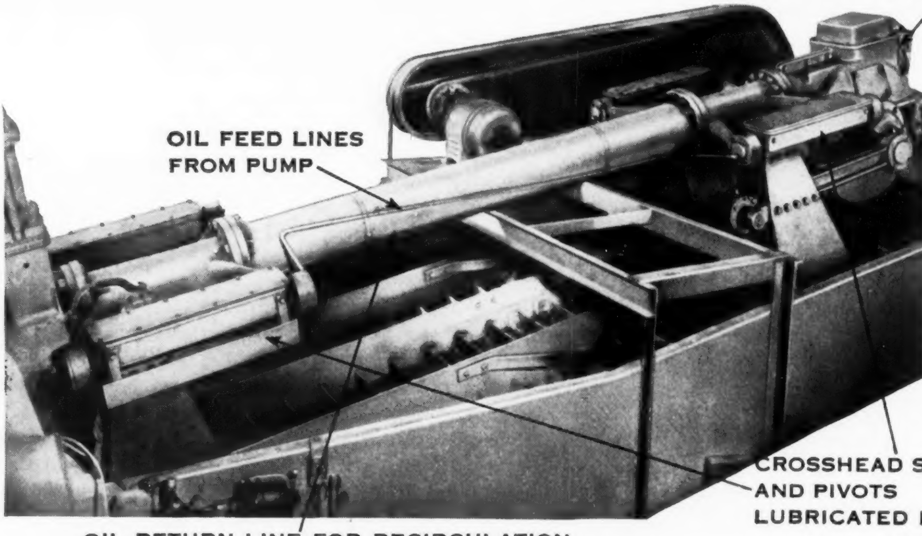


Figure 10 — Showing an H&H heavy-media separator with electrofluid gearmotor and herringbone gear drives to the head shaft of the elevator.

Courtesy of Link-Belt Company



Courtesy of The Dorr Company

Figure 11 — Side elevation of a Dorr classifier indicating certain features of the lubricating system.

Eccentric bearing lubrication must also be carefully controlled, due to the potential loads which may have to be carried. Eccentric bearings may be lubricated by oil reservoirs or grease applied by some form of automatic system. Unless the weight of the pitman is more or less balanced by springs, etc., its weight will be exerted upon the eccentric shaft bearings, with the probable result that the lubricant will be unable to penetrate and maintain the requisite friction-reducing film between the shaft and bearings.

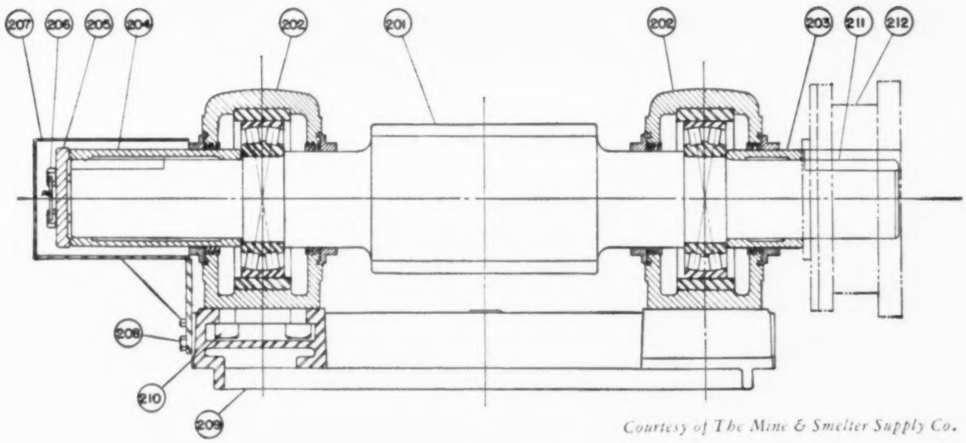
The construction of the crusher must, therefore, always be taken into consideration; where springs and links are used to balance the pitman, reservoir pad lubrication using a fluid grease will probably work out satisfactorily. Where the weight of the pitman is carried on the eccentric bearings, as well as an its own supports, pressure lubrication with a heavier grease will be more positive. A lubricating system which exerts constant pressure on the grease is helpful in maintaining effective lubrication in such service.

Toggle seats may or may not require lubrication, all according to the nature of their construction. Where rolling motion prevails, there may be no need for lubrication. Certain types, however, will involve sliding friction at the toggle seats. In such cases there is usually provision for oil lubrication, by means of suitable drip cups. A relatively heavy machine oil is normally suited for this service.

The Gyratory

The necessary gyratory motion for the main shaft is developed by the eccentric in this type of crusher. This motion must be maintained at a uniform rate to insure maximum crushing ability with minimum power consumption. Lubrication is very important. The eccentric revolves within a bushing and about a shaft so there are two surfaces to be lubricated. In addition, there is the brass wearing ring which carries the weight of the bevel gear and eccentric. In some machines, the base of the machine is also designed to fit loosely in the eccentric to facilitate tipping from side to side. This action may lead to serious overheating and wear unless adequate lubrication is maintained, for all the pressure will be periodically imposed upon a comparatively small area near the top of the thickest part of the eccentric sleeve.

Oil is delivered under positive and constant pressure by means of a suitable oil pump located at the bottom of the crusher, either within or adjacent to the oil reservoir or chamber in the bottom plate. Flood lubrication of this type is beneficial for not only does the oil aid in removal of heat, but the pressure under which it is circulated also tends to counteract to some extent the mechanical pressure which is developed on the contact surfaces when the machine is in operation. An ample supply of oil is contained in the system, which, as a rule, includes a suitable filter or strainer through which the oil passes at each circulation. This, together with the general dust-proof construction of the modern gyratory, insures against the entry and circulation of an excess of dust through the system. As a result, all the lower wearing parts are served with a



Courtesy of The Mine & Smelter Supply Co.

Figure 12 — Roller bearing pinion shaft assembly for a Marcy Mill showing method of sealing for oil retention, and housing arrangement for controlled level for the flood oiling system.

flood of clean, cool oil throughout the period of operation of the gyratory crusher, since the oil pump starts simultaneously with the crusher, operating at a speed commensurate with the rate of crushing.

Outboard bearings steady the shaft and take a great deal of load off the main bearing. A heavy engine or machine oil with a viscosity range of from 500 to 750 seconds Saybolt at 100 degrees Fahr., will usually prove successful in the average countershaft bearing of a gyratory crusher.

On gyratories equipped with gearing, the matter of heavy loading must be considered. As a means of protection dust rings are fitted about the shaft where it enters the gear case and all openings are covered, but despite all these precautions a certain amount of dust may find its way into the gear case to contaminate the gear lubricant. This latter, therefore, should not be too thin or too low in viscosity, otherwise the film developed on the gear teeth might not have sufficient body to prevent them from coming into actual contact under heavy loads. This, of course, would lead to abrasion and wear. As a result, the lubricant used upon these gears should be carefully selected. A non-corrosive, mild E.P. gear lubricant within the SAE-90 range will usually function satisfactorily. It will furthermore resist the drying action of the dust and prevent its packing between the teeth of the gears, thus obviating any tendency in the latter to spring and throw unnecessary pressure upon the countershaft bearings and the eccentric. Where a crusher may have to operate in cold weather, the lubricant used upon the gears should also have a low pour test to insure proper fluidity in service. This will reduce drag, power consumption and the possibility of abnormal wear of tooth surfaces.

ROD AND BALL MILL SERVICE

Grinding is done in a rod or ball mill usually in conjunction with the classifying device. Mills of this type are normally cylindrical. The rotating journals at each end are carried on trunnion bearings. These bearings usually are subjected to

(a) heavy loads
(b) the possibility of overheating
(c) the chance of water or dust contamination

All this requires bearings of comparatively large size. Furthermore, as all the thrust is downward, due to the weight of the mill and its contents these bearings are lined on the bottom half only; this lining being readily replaceable when worn. Inasmuch as the caps of such bearings are not lined, they merely serve as dust shields and receptacles for the oil pads, oil pans or grease blocks where these are used. For oil lubricated bearings a high grade crusher oil is suitable as the medium for saturation. Another procedure is to use flood lubrication from an overhead tank, an oil of around 500 seconds Saybolt Universal at 100° Fahr. being satisfactory.

Good lubricating plus sealing qualities are required whatever the system. As an aid to keeping temperatures down water cooling is provided where dry grinding is involved.

ORE CLASSIFYING

Classifying followed by flotation or tabling, etc. comprises the final step in concentrating before the concentrate is sent to the smelter. In classifying, the rod, tube or ball mill is almost invariably operated in a closed circuit with the classifier to assure fineness of grind. As previously indicated, the discharge from the mill is classified or sized in this unit so that only the finest constituent overflows from the classi-

fier to the next processing step, while the coarser portion of the mill discharge is discharged by the classifier and returned to the feed end of the mill for further grinding.

Separation in the classifier is a wet process which utilizes the principles of gravity and hydraulic counterflow, the idea being that the rate at which the ore particles settle in the classifier is a function of their size and weight, i.e., the smaller the particle, the slower the rate, and the larger the particle, the greater the rate.

The classifier is one of the most important mechanisms in the mill. It is heavy, rugged and durable, built to handle large tonnage by the mechanical action of rakes or spiral blades which aid in separating the coarse material (or sand) from the fines (or pulp). One type of classifier operation requires a head motion involving an eccentric to draw the rake blades along an inclined deck (to move the sand) and then to lift and return them for another stroke. Another design, the spiral type employs a worm to return the oversize.

In the former, heavy duty bronze bushings are used to carry the main shaft, and ball and roller bearings carry the eccentric and crankpins. Most modern construction plans for centralized pressure grease lubrication of all bearings on many classifiers. All are located above the pulp level to preclude lubricant contamination and wear. The gears are also tightly housed for the same purpose. Being of the herringbone type, they can be lubricated by a high grade straight mineral oil ranging from 300 to 800 seconds Saybolt Universal viscosity, according to temperature conditions, or a mild E.P. non-corrosive gear lubricant of around the same viscosity can be used.

In the spiral type of classifier there is an underwater bearing which requires a water-resistant lime soap grease compounded with a fairly heavy well refined mineral oil. On this same type of classifier the bevel gears are open, requiring a heavy bodied gear lubricant for their protection.

IN THE SMELTER

When the lubrication engineer considers the smelter he is concerned with excessive heat and cold in contrast to the water condition which prevails in the lubrication of modern ore dressing machinery. Lubricants therefore are selected to meet these conditions.

In the smelter the concentrated ores are converted from mineral combinations to more or less pure metal. This may be accomplished in a roasting furnace, or melting in a blast furnace or reverberatory, according to the type of metals to be recovered. The blast furnace is widely used where lead is smelted; the roaster or sintering furnace with zinc ores; and the reverberatory and converter where copper ores are involved.

Furnace charging machinery such as larry cars, and the rotating casting machines must be carefully lubricated. In the copper refinery the casting machines take the hot metal discharge from the anode furnace. Obviously all metals must be poured above their melting point temperature. The maximum prevails with copper, viz., around 2000° F. The operating mechanism of the casting machine is so close to the hot metal that the radiated heat and fumes surrounding the working parts are extreme during the entire course of operation. Lubrication under such consistently high temperature conditions can obviously be a problem. It can only be successfully maintained by coordination of the means of application with the heat-resisting qualities of the lubricant.

The builders of the machinery have anticipated this by designing so that the necessary gear mechanisms and bearings are carefully housed and protected to prevent undue leakage of their lubricants. In the selection of oils and greases for such service, the viscosity and flash points of the oils and the melting points of greases must be watched. Normally the viscosity or body will be indicative of the temperature-resisting ability of an oil. Of necessity, it must be comparatively high. This is why lubricants of steam cylinder nature are so widely preferred. Furthermore, they possess high flash points, so their vaporizing tendency is low. Such oils can be used alone, as for example, to lubricate heavy-duty ball or roller bearings or enclosed gear sets, or they may be compounded in the manufacture of high temperature greases.

CONCLUSION

Non-ferrous metals are of vital interest to the lubrication engineer. He is concerned with copper, tin, lead, zinc, antimony, nickel and cadmium as constituents of modern bearings; he is concerned with tungsten, titanium, molybdenum and vanadium as components used for alloying steels; and he is concerned with lead as a soap-base in the manufacture of extreme pressure greases, and aluminum as a soap base for certain other greases. This interest is accentuated today because most of these metals are under high priority classification.

Lubrication plays an important part in their production, from mine to finished product. Modern mining machinery has been greatly improved as to speed and application of automatic lubrication systems. It is heavy-duty in nature, costly and so correlated that failure of any part may interfere seriously with the production schedule. It is the duty of the lubrication engineer to work with mine personnel to forestall such failures.

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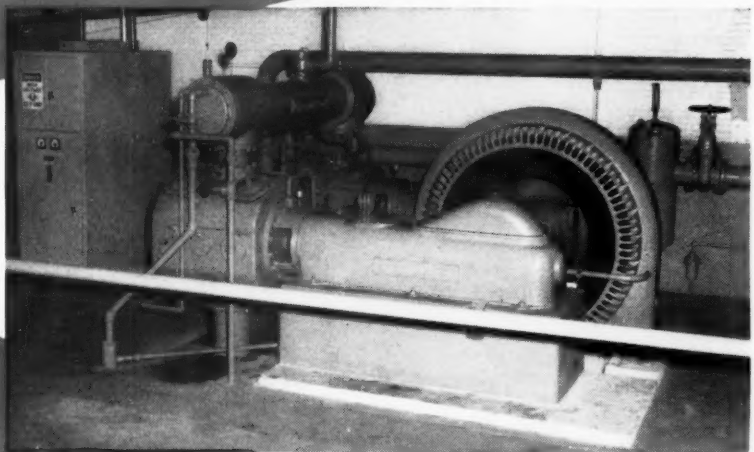

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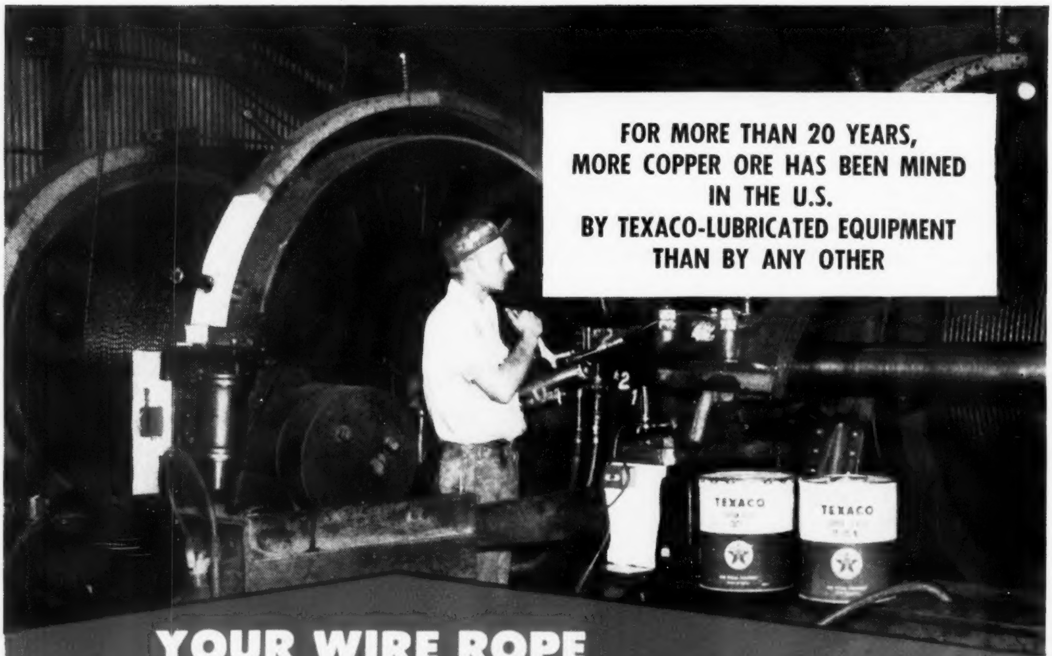

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